AD-774 458

LASA REGIONAL TRAVEL-TIME CORRECTIONS AND ASSOCIATED NODES

E. F. Chiburis, et al

Teledyne Geotech

Prepared for:

Advanced Research Projects Agency
Air Force Technical Applications Center

9 October 1973

DISTRIBUTED BY:

NTIS

National Technical Information Service
U. S. DEPARTMENT OF COMMERCE
5285 Port Royal Road, Springfield Va. 22151

Best
Available
Copy

SDAC-TR-73-6

LASA REGIONAL TRAVEL-TIME CORRECTIONS AND ASSOCIATED NODES

E. F. CHIBURIS

CONSULTANT TO THE SEISMIC DATA ANALYSIS CENTER

R. O. AHNER

Seismic Data Analysis Center

Teledyne Geotech, 314 Montgomery Street, Alexandria, Virginia 22314

9 October 1973

Sponsored By

The Defense Advanced Research Projects Agency

Nuclear Monitoring Research Office

1400 Wilson Boulevard, Arlington, Virginia 22209

ARPA Order No. 1620

Monitored By

VELA Seismological Center

312 Montgomery Street, Alexandria, Virginia 22314

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER SDAC-TR-73-6	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) LASA REGIONAL TRAVEL-TIME CORRECTIONS AND ASSOCIATED NODES		5. TYPE OF REPORT & PERIOD COVERED Technical 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Chiburis, E. F. and Ahner, R. O.		8. CONTRACT OR GRANT NUMBER(s) F08606-74-C-0006
9. PERFORMING ORGANIZATION NAME AND ADDRESS Teledyne Geotech 314 Montgomery Street Alexandria, Virginia 22314		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Defense Advanced Research Projects Agency Nuclear Monitoring Research Office 1400 Wilson Blvd.-Arlington, Va. 22209		12. REPORT DATE 9 October 1973 13. NUMBER OF PAGES 33
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) Vela Seismological Center 312 Montgomery Street Alexandria, Virginia 22314		15. SECURITY CLASS. (of this report) 15a. DECLASSIFICATION DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for Public Release; Distribution Unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Seismic
Large Aperture Seismic Array
Travel-Time Anomalies
Crosscorrelation
Beampacking
Inverse Velocity Space
Detection Processor
Event Processor
Region Corrections

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A new set of region corrections has been generated for LASA which more adequately covers the seismically active area of the earth than did previous sets. The new set contains 183 calibration nodes versus 105 nodes on the set used in the SDAC/LASA system throughout 1972 and the first half of 1973. Each node contains the average relative travel-time anomalies for each of the 21 subarrays at LASA which are valid over an area surrounding the location of the node. The corrections were generated from more than 1800 events

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

using as a primary source of data the time shifts resulting from the crosscorrelation process in the SDAC/LASA Event Processor.

LASA REGIONAL TRAVEL-TIME
CORRECTIONS AND ASSOCIATED NODES

Seismic Data Analysis Center Report No.: SDAC-TR-73-6

AFTAC Project No.:	VELA VT/4709
Project Title:	Seismic Data Analysis Center
ARPA Order No.:	1620
ARPA Program Code No.:	3F10
Name of Contractor:	TELEDYNE GEOTECH
Contract No.:	F08606-74-C-0006
Date of Contract:	01 July 1973
Amount of Contract:	$2,152,172
Contract Expiration Date:	30 June 1974
Project Manager:	Robert G. Van Nostrand (703) 836-3882

P. O. Box 334, Alexandria, Virginia 22314

Approved for Public Release; Distribution Unlimited.

ABSTRACT

A new set of region corrections has been generated for LASA which more adequately covers the seismically active areas of the earth than did previous sets. The new set contains 183 calibration nodes versus 105 nodes on the set used in the SDAC/LASA system throughout 1972 and the first half of 1973. Each node contains the average relative travel-time anomalies for each of the 21 subarrays at LASA which are valid over an area surrounding the location of the node. The corrections were generated from more than 1800 events using as a primary source of data the time shifts resulting from the crosscorrelation process in the SDAC/LASA Event Processor.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

In array processing, beamforming is the principal method of detecting teleseismic signals. Basically, the method requires that suitable relative time delays, appropriate to the array elements, be determined for the location at which the beam is aimed. To calculate the delays some earth model, or travel time and distance relationship, must be assumed. However, since the earth is not known well enough to predict relative travel times to within 0.1-0.2 seconds, an additional procedure must be followed. When a teleseismic signal is recorded by the various array elements, the relative arrival times can be observed. By comparing the observed relative times to the theoretical relative times computed from a known epicentral location and from the adopted model, travel-time anomalies can be calculated in the manner suggested by Chiburis and Dean (1965, p. 2). The beam delays can then be corrected to compensate for the anomalies such that acceptable signal alignment of future events is achieved.

Our experience has shown that, although the array anomalies are reproducible (that is, constant) for events from any particular geographic region, they vary significantly from one region to another (Chiburis and Dean, 1965; Chiburis, 1966; and Chiburis, 1968). This fact requires that a set of anomalies be calculated for every region where an array beam is aimed.

The data processing system for the Large Aperture Seismic Array (LASA) at the Seismic Data Analysis Center (SDAC), as programmed by IBM under Contracts F-19628-C-0198 and F-19628-68-C-0400, employs 105 regions (or nodes, to emphasize their point nature) for which corrections are assumed known. The LASA Detection Processor (DP) has 300 beams spatially distributed so that the signal loss between beam centers is generally less than 3db. Each set of beam delays has been modified by corrections which were determined by a tripartite interpolation scheme using the 105 nodes. Clearly, a good correction set which offers adequate coverage is critical to all of the array processes of beamforming and location.

This report discusses the current set of nodes, the interpolation scheme, and the establishment of a new set containing nearly 200 nodes, each consisting of 21 subarray corrections as determined from more than 1800 well-recorded events.

The Current System

The Event Processor (EP) of the SDAC/LASA system has as one of its processing options a correlation scheme whereby each subarray time series is crosscorrelated, with lags, with the array beam pointed at the DP location. When the signals are large enough for this process to work, a set of time shifts (lags) is determined from which a final beam is formed. The correlated time shifts are modified by the assumed-known corrections, after which a velocity and an azimuth are determined and a corresponding location is computed.

Should the crosscorrelation process fail because of poor signal power, of signal decorrelation, or of insufficient lags for a badly misaligned detection beam, the EP invokes a beampacking process. In this process, a set of 18 beams is iteratively formed around the detection beam and the beam having the largest power is selected. Each of the beams in the pack has predicted delays modified by the interpolated corrections.

Between January 1971 and May 1972, the SDAC/LASA system operated with the crosscorrelation method. As shown by Ahner (1973), beampacking is far faster and yields results as good as, and often better, than crosscorrelation. Therefore, since May 1972, beampacking has been the principal method of the EP.

The current node set and the tripartite tie points generated by IBM are shown plotted in U-space in Figure 1. For events occurring between nodes and within a triangle, a proportional 3-way linear interpolation is made to obtain the subarray corrections. It can be seen that about 1 dozen of the 105 nodes cover the region where U < 0.04 sec/km (beyond the P-range distance). Interpolating between corrections for P and (for example) PKP is invalid; in this case, it would probably be better to apply no time corrections at all to events beyond the P-range. The remaining nodes in Figure 1 provide dense enough coverage only in the upper left quadrant (to the northwest of LASA, from southern Alaska through the Aleutians, Kamchatka, The Kuriles, and Japan, to the Marianas). About one fourth of the 105

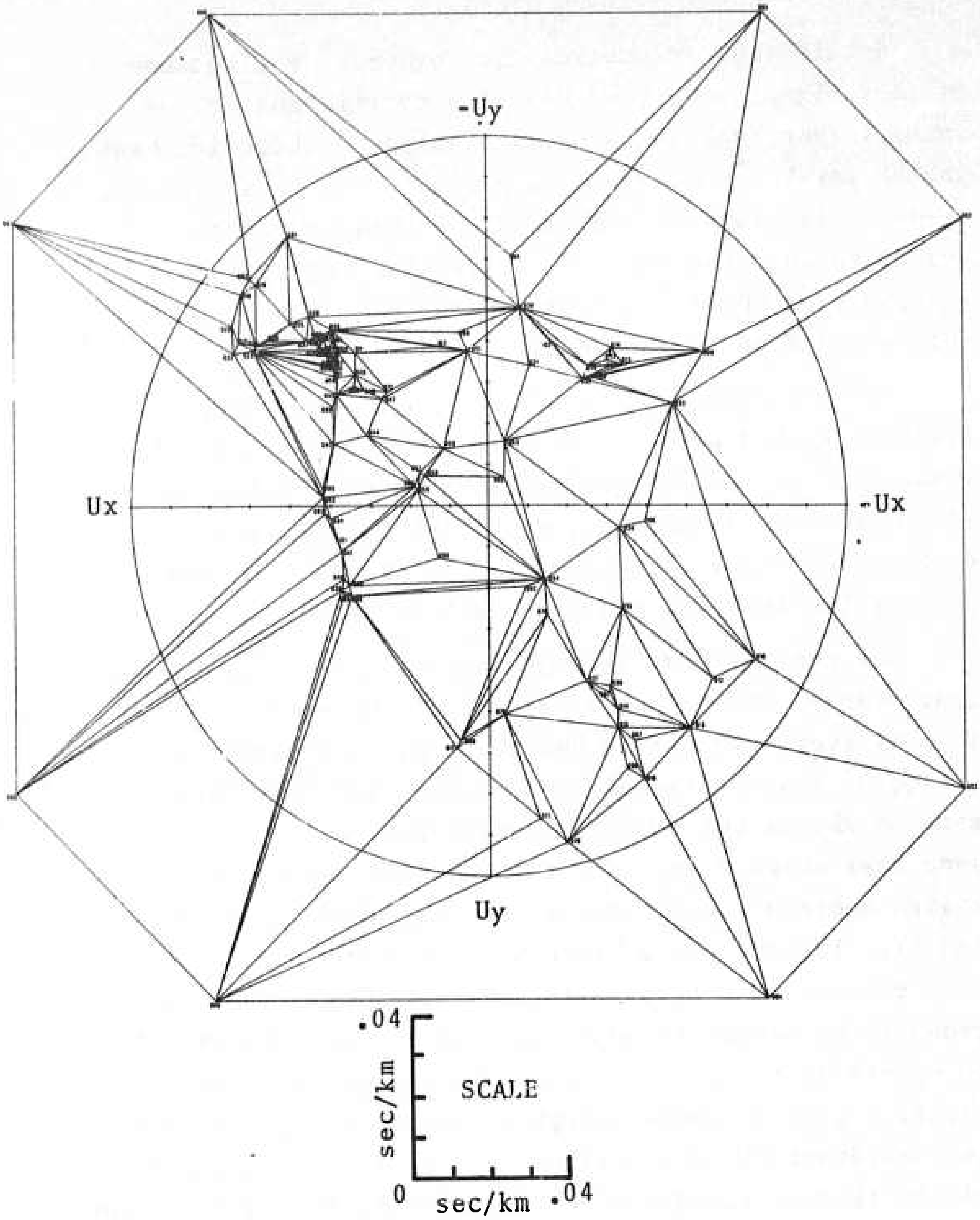

Figure 1. Inverse Velocity Space Deployment of Region Correction Nodes Supplied by IBM.

nodes inadequately cover the remaining three quadrants. As an example of the poor coverage, consider the Azores Islands Region and the North Atlantic Ridge in the northeast quadrant (azimuth 65-85°) at U-radius of about 0.06 sec/km. As seen in Figure 1, all corrections for this area would be interpolated between a node located in Morroco and two nodes in Eastern Montana. It is not surprising that events occurring in this region reported by SDAC/LASA often display misalignments greater than 0.5 seconds with the result that the array beam signal is 3-6db smaller than it should be. More importantly, events from this area which are near but above an achievable detection threshold of LASA are probably being missed entirely in DP because of improperly corrected delays. Referring again to Figure 1, there are only four nodes covering the Asian continent, and no node at all for the Hawaiian region. Beams directed in these areas are almost certainly being poorly steered.

This lack of coverage in certain regions and improper coverage in others prompted us to undertake a redesign of nodal placement and a redetermination of a correction set as completely as possible.

The New Node and Correction Set

In an earlier report, Chiburis and Dean (1965) showed that a comparison of array time shifts determined by visual observation and by crosscorrelation of very good signals could yield results within 0.1-0.2

seconds of each other. Therefore, the time shifts resulting from the crosscorrelation process in EP between February 1971 and May 1972 were used as a primary source of data from which to calculate region corrections.

The procedure used was to punch cards from the Event Tape containing the epicentral parameters and the 21 relative time shifts. The events were associated with those reported by the Earthquake Research Lab (ERL) of the National Oceanic and Atmospheric Administration (NOAA). From the ERL hypocenters and the crosscorrelated time shifts, travel-time anomalies were computed using the Herrin (1968) travel-time tables, which are the tables used in the SDAC/LASA system. More than 40,000 anomalies were computed in this way and regionalized. Because the crosscorrelation process occasionally misaligns a subarray signal by a full cycle, and because it often misaligns a signal by 0.2-0.3 seconds, a considerable number of the time shifts must be visually read from the plots of the event in order to establish good corrections.

The regions into which the events were placed define the 183 nodes shown in Figure 2. The tripartite tie points were determined with a knowledge of the seismicity between nodes and with a view toward weighting seismically active regions more than relatively aseismic regions for the three-point interpolation scheme. As seen in Figure 2, the quadrants are about equally covered with nodes. It is estimated that nearly 80%

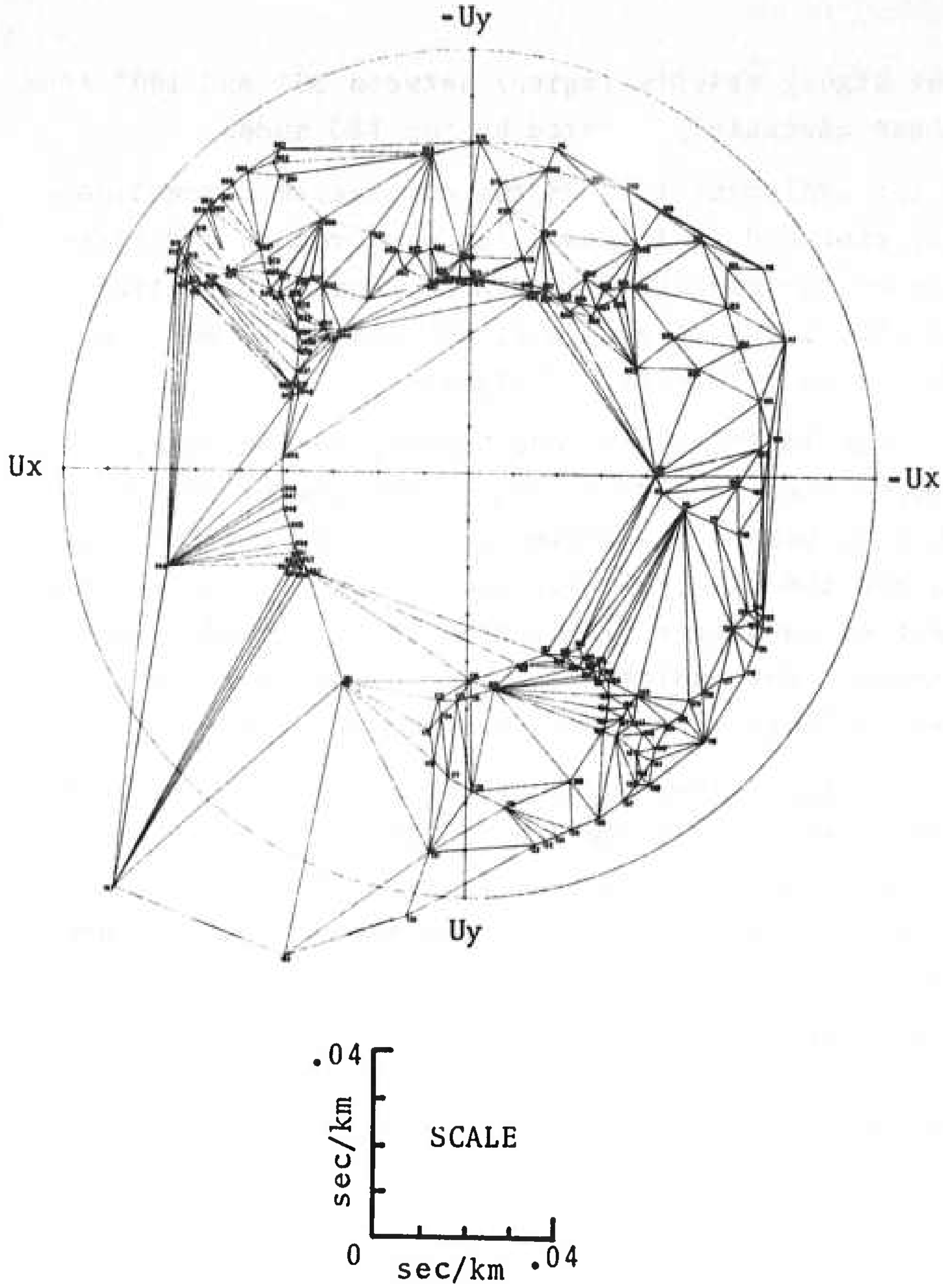

Figure 2. New Inverse Velocity Space Deployment of Region Correction Nodes.

of the highly seismic regions between 30° and 100° from LASA are adequately covered by the 183 nodes.

The implementation of the new region correction set is expected to increase the performance and efficiency of the SDAC/LASA system as regards detection threshold, location accuracy, EOC analysis, and the reprocessing of misaligned signals.

Table IA lists the Node Number, Region Name, Geographic and U-Space location, the Number of Events which were used to determine the corrections for that node, and the LASA velocity and azimuth; Table IB lists the set of anomalies (in hundredths of seconds) for the nodes. For implementation as corrections, the values in Table IB must be reversed in sign.

Additional events, occurring in new regions or in regions where only a few events were available, are being analyzed on a time available basis and will provide for periodic updates and improvements to the new region correction set.

A report on the performance of the new set relative to the original and current set will be issued as soon as enough data have been accumulated.

CONCLUSIONS

Our experience with operating the SDAC/LASA system led us to believe that a large percentage of signals were not being as well aligned as possible in the beamforming process. This misalignment would cause the system to miss signals from events above the achievable detection threshold as well as seriously mislocate the detected events. A preliminary analysis of the current placement of 105 nodes and of the region correction set in the system confirmed that many of the seismic regions between 30° and 100° were not properly calibrated or were not calibrated at all.

A new set consisting of 183 nodes was developed. A region correction set for the 21 subarrays at LASA was generated from more than 1800 events, using as the source of data the time shifts resulting from the crosscorrelation process in EP.

The implementation of the new region correction set is expected to improve the detection threshold, to yield more accurate locations, and increase the efficiency of the SDAC/LASA system.

ACKNOWLEDGEMENT

The authors gratefully acknowledge the assistance of Messrs. R. M. Seggelke, J. S. Fyfe, and R. S. Nau in gathering the data, modifying the computer programs, and implementing our new Region Corrections.

REFERENCES

Ahner, R. O., 1973, A comparison of the location refinement techniques in the SDAC/LASA Event Processor, Teledyne Geotech, in publication.

Chiburis, E. F., and Dean, W. C., 1965, Teleseismic signal alignment at the Tonto Forest Extended Array, Teledyne Geotech, SDL Report No. 125.

Chiburis, E. F., 1966, Relative travel-time anomalies and the location of epicenters using "SHIFT", Teledyne Geotech, SDL Report No. 147.

Chiburis, E. F., 1968, LASA travel-time anomalies for 65 regions computed with the Herrin travel-time table. November 1966 version; Teledyne Geotech, SDL Report No. 204.

Herrin, Eugene, 1968, Seismological tables for P; Bull. Seis. Soc. Am., v. 58, pp. 1196-1219.

TABLE IA

New Region Correction Nodes

mber	Region Name	Geographic Lat.	Long.	U-Space U_x sec/km x 10-5	U_y	Number Events in Region	Velocity Km/Sec	Azimuth Degrees
1	Chukchi Sea	67.5N	171.5W	4213	-6249	1	13.3	326
2	Northeastern Alaska	66.5N	144.8W	4224	-6812	1	12.5	328
3	Western Alaska	67.1N	157.0W	4360	-6529	1	12.7	326
4	Southern Alaska	60.2N	148.3W	5741	-5616	7	12.5	314
5	Central Alaska	64.0N	149.1W	4935	-6313	5	12.5	322
6	Mt. McKinley Area	62.7N	151.2W	5254	-6033	8	12.5	319
7	Alaska Range	61.3N	151.3W	5550	-5774	4	12.5	316
8	Seward Peninsula	59.8N	152.3W	5848	-5453	4	12.5	313
9	Cook Inlet	60.2N	153.4W	5762	-5506	4	12.5	314
10	No. Alaska Peninsula	58.2N	154.1W	6121	-5086	5	12.6	310
11	Kodiak and Gulf of Alaska	56.6N	152.5W	6425	-4762	5	12.5	307
12	Alaska Peninsula	56.1N	157.4W	6385	-4613	4	12.7	306
13	So. Alaska Peninsula	55.4N	163.0W	6291	-4465	5	13.0	305
14	Unimak Island	53.9N	162.6W	5485	-4175	8	13.0	303
15	Eastern Fox Islands	52.9N	167.1W	6376	-4022	5	13.3	302
16	Western Fox Islands	52.3N	170.7W	6243	-3958	13	13.5	302
17	Eastern Andreanof Islands	52.1N	173.3W	6135	-3968	13	13.7	303
18	Central Andreanof Islands	51.2N	175.2W	6090	-3851	10	13.9	302
19	Western Andreanof Islands	51.3N	178.2W	5920	-3916	46	14.1	303
20	Rat Islands	51.6N	178.3E	5703	-4011	27	14.3	305
21	Near Islands	52.5N	172.1E	5299	-4210	17	14.8	308
22	Komandorsky Is. and Kamchatka	55.8N	163.2E	4624	-4687	60	15.2	315
23	Kamchatka	53.0N	159.4E	4575	-4418	16	15.7	314
24	Northern Kurile Islands	50.3N	156.0E	4496	-4182	19	16.3	313
25	Central Kurile Islands	45.5N	151.5E	4398	-3826	20	17.2	311
26	Southern Kurile Islands	43.9N	147.7E	4200	-3754	30	17.8	312

TABLE IA (Continued)

Node Number	Region Name	Geographic Lat.	Geographic Long.	U-space U_x sec/km x 10^{-5}	U-space U_y sec/km x 10^{-5}	Number Events in Region	Velocity Km/Sec	Azimuth Degrees
27	Sea of Okhotsk	48.9N	148.1E	4107	-4179	5	17.1	316
28	Hokkaido, Japan	42.1N	143.3E	3936	-3662	43	18.6	313
29	Northern Honshu, Japan	39.8N	141.2E	3822	-3511	34	19.3	313
30	Sakhalin Island	46.5N	141.2E	3764	-4072	14	18.0	317
31	Near East Coast of Russia	46.2N	137.2E	3517	-4081	1	18.6	319
32	E. Russia-NE China Border	43.4N	132.2E	3263	-3931	1	19.6	320
33	Honshu, Japan	36.2N	140.5E	3786	-3244	41	20.1	311
34	South of Honshu, Japan	32.3N	141.1E	3806	-2937	80	20.8	308
35	North of Bonin Islands	29.2N	140.0E	3688	-2718	12	21.8	306
36	Bonin Islands	27.0N	142.0E	3769	-2506	5	22.1	304
37	Northern Mariana Islands	21.5N	144.0E	3810	-2084	14	23.0	299
38	Mariana Islands	19.0N	147.0E	3936	-1828	11	23.0	295
39	Western Mariana Islands	18.4N	145.5E	3849	-1844	13	23.4	296
40	South of Mariana Islands	15.0N	147.0E	3898	-1598	23	23.7	292
41*	South of Mariana Islands	11.0N	141.0E	3741	-1679	23	24.4	294
42	Shikoku, Japan	31.8N	132.0E	3194	-3028	7	22.7	313
43	Ryukyu Islands	29.3N	130.7E	3128	-2910	10	23.4	313
44	Taiwan	23.0N	121.7E	2840	-2970	14	24.3	316
45	New Ireland	4.2S	154.5E	4092	- 276	3	24.4	274
46	Solomon Islands	10.5S	161.3E	4082	389	5	24.4	265
47	Southeastern Solomon Islands	11.0S	163.7E	4070	537	3	24.4	262
48	Santa Cruz Islands	10.3S	169.7E	4066	814	1	24.1	259
49	New Hebrides Islands	18.5S	168.9E	3929	1158	2	24.4	254
50	Fiji Islands	17.9S	177.4E	3836	1546	7	24.2	248
51	Northern Fiji-Tonga Islands	16.6S	178.0W	3843	1742	43	23.7	246

TABLE IA (Continued)

Node Number	Region Name	Geographic Lat.	Geographic Long.	U-space U_x sec/km x 10^{-5}	U-space U_y sec/km x 10^{-5}	Number Events in Region	Velocity Km/Sec	Azimuth Degrees
52	Southern Fiji-Tonga Islands	21.7S	179.0W	3677	1874	58	24.2	243
53	Tonga Islands	17.8S	175.0W	3777	1953	25	23.5	243
54	Samoa Islands	15.3S	173.3W	3919	1998	14	22.7	243
55	South of Samoa Islands	17.2S	173.0W	3815	2065	9	23.1	242
56	Eastern Central Tonga Islands	20.5S	174.0W	3650	2090	14	23.8	240
57	South of Tonga Islands	24.8S	176.1W	3532	2127	18	24.3	239
58	Hawaiian Islands	19.4N	155.3W	6614	2051	5	14.4	253
59	Severnaya Zemlya	81.9N	118.9E	903	-6777	1	14.6	352
60	Siberia	61.7N	143.5E	3288	-5333	2	16.0	328
61	Southeastern Siberia	57.0N	117.3E	2201	-5047	2	18.2	336
62	Mongolia	46.7N	101.8E	1486	-4320	1	21.9	341
63	Siberia-Mongolia	50.6N	97.3E	1232	-4624	1	20.9	345
64	Southern Siberia	52.2N	91.4E	913	-4743	1	20.7	349
65	Lake Baikal Region	51.8N	105.3E	1649	-4691	2	20.1	341
66	Northeastern China	37.8N	115.5E	2271	-3657	3	23.2	328
67	Tibet	34.5N	88.5E	871	-4015	2	24.3	348
68	Northern Sinkiang	43.9N	86.8E	692	-4191	2	23.5	351
69	Sinkiang	42.0N	84.2E	565	-4157	4	23.8	352
70	Western Sinkiang	39.5N	78.5E	263	-4123	15	24.2	356
71	Kirghiz-Tadzhik	40.0N	72.5E	-71	-4140	14	24.2	1
72	Hindu Kush	35.8N	71.0E	-163	-4098	5	24.4	2
73	Eastern Kazakh	49.9N	78.0E	219	-4570	11	21.9	357
74	Arctic Ocean	87.0N	53.5E	-177	-7045	1	14.2	1
75	Novaya Zemlya	73.4N	55.0E	-665	-6157	2	16.1	6

TABLE IA (Continued)

Node Number	Region Name	Geographic Lat.	Geographic Long.	U-space U_X sec/km x 10^{-5}	U-space U_Y sec/km x 10^{-5}	Number Events in Region	Velocity Km/Sec	Azimuth Degrees
76	Ural Mountains	64.2N	55.2E	-844	-5574	3	17.7	9
77*	Western Russia	57.8N	41.1E	-1626	-5109	3	18.7	18
78	Western Kazakh	49.8N	51.4E	-1173	-4561	2	21.2	14
79	Caucasus	41.0N	48.0E	-1389	-3986	7	23.7	19
80	Western Iran	33.8N	49.8E	-1398	-3855	2	24.4	20
81	Iraq	36.0N	44.5E	-1646	-3801	3	24.1	23
82	Eastern Turkey	40.3N	41.8E	-1725	-3894	9	23.[illegible]	24
83	Southern Central Turkey	37.1N	36.7E	-2031	-3691	5	23.7	29
84	Lebanon-United Arab Republic	30.7N	34.7E	-2246	-3452	2	24.3	33
85	Western Turkey	38.2N	28.2E	-2476	-3626	47	22.8	34
86	Crete	34.5N	23.5E	-2758	-3348	24	23.1	39
87	Southern Greece	37.7N	22.0E	-2847	-3542	18	22.0	39
88	Yugoslavia	43.0N	19.5E	-3007	-3930	4	20.2	37
89	Rumania	45.6N	26.2E	-2594	-4173	2	20.4	32
90	Southern Italy	40.9N	15.3E	-3271	-3728	4	20.2	41
91	Central Italy	44.5N	12.5E	-3411	-3969	13	19.1	41
92	Switzerland-No. Italy	45.5N	8.3E	-3658	-4008	4	18.4	42
93	Southern Algeria	24.0N	5.1E	-3745	-2284	1	22.8	59
94	Canary Islands	31.2N	13.9W	-5115	-2270	1	17.9	66
95	Straits of Gibralter	35.5N	5.0W	-4550	-2917	2	18.5	57
96	North Sea	56.6N	0.7E	-3726	-4861	1	16.3	37
97	Svalbard Islands	76.3N	16.0E	-1714	-6468	2	14.9	15
98	Jan Mayen Island	71.6N	2.8W	-2715	-6207	4	14.8	24
99	North of Iceland	68.5N	17.6W	-3519	-6050	3	14.3	30

TABLE IA (Continued)

Node Number	Region Name	Geographic Lat.	Geographic Long.	U-space U_x sec/km x 10^{-5}	U-space U_y sec/km x 10^{-5}	Number Events in Region	Velocity Km/Sec	Azimuth Degrees
100	Iceland	64.0N	22.8W	-4227	-5611	6	14.2	37
101	Atlantic Ridge 1	58.6N	31.4W	-5164	-4978	6	13.9	46
102	Atlantic Ridge 2	54.7N	35.3W	-5715	-4406	4	13.9	52
103	Atlantic Ridge 3	48.0N	27.6W	-5712	-3591	3	14.8	58
104	Atlantic Ridge 4	41.7N	29.4W	-6007	-2738	2	15.1	65
105	Atlantic Ridge 5	35.2N	36.3W	-6458	-1604	1	15.0	76
106	Atlantic Ridge 6	31.3N	41.3W	-6686	- 799	4	14.9	83
107	Atlantic Ridge 7	28.3N	39.2W	-6491	- 599	2	15.3	85
108	Atlantic Ridge 8	23.5N	44.8W	-6556	370	1	15.2	93
109	Atlantic Ridge 9	18.4N	36.8W	-6004	176	1	16.2	92
110	Atlantic Ridge 10	14.0N	45.0W	-6021	1227	4	16.3	102
111	Atlantic Ridge 11	8.0N	37.6W	-5507	995	5	17.9	100
112	Atlantic Ridge 12	1.8N	29.4W	-4826	713	5	20.5	98
113	Atlantic Ridge 13	0.8S	22.0W	-4358	361	4	22.9	95
114	North of Ascension I.	0.4S	15.6W	-4202	- 14	3	23.8	90
115	Western Greenland Sea	79.4N	17.8W	-1906	-6928	1	13.9	15
116	Labrador Sea	55.1N	54.4W	-6504	-4400	1	12.7	56
117	Off Coast of Newfoundland	47.4N	49.4W	-7008	-2902	1	13.2	68
118	Caribbean Sea	17.9N	81.7W	-5330	5638	1	12.9	137
119	Haiti	18.2N	72.3W	-6189	4181	3	13.4	124
120	Dominican Republic	18.8N	68.9W	-6420	3642	9	13.5	120
121	Puerto Rico	19.4N	66.3W	-6569	3229	2	13.7	116
122	North of Virgin Islands	19.1N	64.5W	-6568	3006	4	13.8	115
123	Virgin Islands	18.1N	64.5W	-6476	3093	1	13.9	116

TABLE IA (Continued)

Node Number	Region Name	Geographic Lat.	Geographic Long.	U-space U_x sec/km x 10^{-5}	U-space U_y sec/km x 10^{-5}	Number Events in Region	Velocity Km/Sec	Azimuth Degrees
124	Leeward Islands	17.1N	61.9W	-6423	2836	1	14.2	114
125	Northern Windward Islands	15.0N	60.8W	-6247	2858	5	14.6	115
126	Southern Windward Islands	11.5N	61.9W	-5922	3219	8	14.8	119
127	Off Coast of Venezuela	12.4N	70.7W	-5679	4301	1	14.0	127
128	Colombia-Venezuela Border	9.2N	72.0W	-5277	4588	2	14.3	131
129	Northern Colombia Deep	6.8N	72.9W	-4978	4753	24	14.5	134
130	Southern Gulf of California	25.3N	109.4W	1300	9406	6	10.3	188
131	Revilla Gigedo	19.6N	109.0W	811	8050	4	12.4	186
132	Guerrero, Mexico	18.3N	100.5W	-1581	7858	5	12.5	169
133	Off Coast of Guerrero	16.8N	99.3W	-1823	7769	5	12.5	167
134	Oaxaca, Mexico	16.3N	98.1W	-2089	7661	8	12.6	165
135	Off Coast of Oaxaca	15.4N	96.5W	-2411	7518	2	12.7	162
136	Chiapas, Mexico	15.6N	93.9W	-3002	7283	17	12.7	158
137	Guatemala	14.0N	90.5W	-3544	6902	15	12.9	153
138	Honduras	14.7N	87.6W	-4121	6556	1	12.9	148
139	Off Coast of Central America	12.2N	87.8W	-3837	6561	5	13.2	150
140	Nicaragua	11.0N	86.4W	-3938	6380	12	13.3	148
141	Costa Rica	9.3N	83.6W	-4173	6048	3	13.6	145
142	South of Panama	7.3N	81.4W	-4251	5779	3	13.9	144
143	Off Coast of Colombia	4.2N	82.6W	-3833	5877	4	14.3	147
144	Colombia	5.6N	77.1W	-4526	5269	6	14.4	139
145	Northern Colombia	7.3N	75.5W	-4831	5068	2	14.3	136
146	Colombia-Ecuador Border	1.2N	79.0W	-3960	5459	5	14.8	144
147	Peru-Ecuador Border	3.0S	77.5W	-3756	5252	9	15.5	144
148	Off Coast Ecuador	4.0S	80.8W	-3377	5529	12	15.4	149

TABLE IA (Continued)

Node Number	Region Name	Geographic Lat.	Geographic Long.	U-space U_x sec/km x 10^{-5}	U-space U_y sec/km x 10^{-5}	Number Events in Region	Velocity Km/Sec	Azimuth Degrees
149	Peru-Brazil Border	7.8S	71.6W	-3832	4657	3	16.6	141
150	Northern Peru-Intermediate	7.6S	74.7W	-3624	4919	5	16.4	144
151	Northern Peru-Shallow	6.5S	77.0W	-3529	5140	5	16.0	146
152	Off Coast of Northern Peru	8.0S	80.9W	-3084	5421	4	16.0	150
153	Central Peru Coast	9.8S	78.8W	-3152	5216	13	16.4	149
154	Central Peru	12.2S	76.3W	-3188	4963	13	17.0	147
155	Southern Peru	15.0S	73.1W	-3224	4665	15	17.6	145
156	Peru-Chile-Bolivia Border	17.9S	69.9W	-3195	4343	16	18.5	144
157	Northern Chile Coast	20.7S	70.6W	-2964	4316	10	19.1	146
158	Chile-Bolivia Border	21.2S	68.6W	-3034	4173	24	19.4	144
159	Bolivia-Argentina Border	23.2S	66.7W	-2980	3992	19	20.1	143
160	Chile-Bolivia-Argentina Border	24.0S	68.9W	-2830	4113	14	20.0	145
161	Antofagasta, Chile	23.5S	70.5W	-2791	4237	17	19.7	147
162	Atacama, Chile	27.7S	70.3W	-2528	4079	12	20.8	148
163	Central Chile	32.0S	71.5W	-2197	3948	68	22.1	151
164	Chile-Argentina Border	33.0S	70.0W	-2196	3825	18	22.7	150
165	Catamarca, Argentina	28.0S	67.2W	-2633	3877	6	21.3	146
166	Central Argentina	30.3S	65.1W	-2540	3654	4	22.5	145
167	So. Chile-Argentina Border	39.2S	73.0W	-1790	3804	5	23.8	155
168	Off Coast of Southern Chile	41.7S	84.2W	-1183	4043	1	23.7	164
169	Chile Rise 1	36.7S	96.8W	- 609	4561	2	21.7	172
170	Southern Pacific Ocean	39.8S	104.9W	- 78	4392	3	22.7	179
171	Chile Rise 2	35.3S	104.9W	- 90	4741	2	21.	179
172	Chile Rise 3	33.9S	109.2W	212	4834	2	20.	183
173	Easter Island Cordillera 1	33.3S	115.1W	637	4812	1	20.6	188

TABLE IA (Continued)

Node Number	Region Name	Geographic Lat.	Geographic Long.	U-space U_x sec/km x 10-5	U-space U_y sec/km x 10-5	Number Events in Region	Velocity Km/Sec	Azimuth Degrees
174	Easter Island Cordillera 2	28.7S	113.3W	579	5144	1	19.3	186
175	Easter Island Cordillera 3	23.7S	115.1W	827	5452	3	18.1	189
176	Easter Island Cordillera 4	13.3S	112.2W	722	6125	1	16.2	187
177	Easter Island Cordillera 5	8.8S	109.2W	404	6464	3	15.4	184
178	Easter Island Cordillera 6	4.6S	105.3W	- 139	6747	2	14.8	179
179	Easter Island Cordillera 7	1.6N	101.1W	- 899	7087	1	14.0	173
180	Galapagos Islands	0.2S	91.4W	-2363	6499	7	14.5	160
181	Tuamotu Archipelago	21.9S	139.0W	2733	4466	1	19.1	211
182	Northern Gulf of California	29.6N	113.5W	3927	10263	3	9.1	201
183	Los Angeles	34.4N	118.4W	7758	8856	1	8.5	221

* Nodes duplicated for interpolation purposes.

TABLE IB

New Travel-Time Anomalies in Hundredths of Seconds

Node No.	A0	B1	B2	B3	B4	C1	C2	C3	C4	D1	D2	D3	D4	E1	E2	E3	E4	F1	F2	F3	F4
1	0	2	-8	-3	2	5	-4	2	-5	-3	-16	-28	-16	-19	4	-30	-29	4	-41	-18	-29
2	0	11	3	2	8	12	-1	4	5	16	-11	-17	-2	-2	21	-13	-32	6	-12	-12	-16
3	0	11	14	11	3	23	18	4	13	13	9	-1	10	-6	15	-9	-18	3	-21	19	-7
4	0	7	6	-8	-1	12	5	-5	-7	4	-7	-17	-4	-13	0	-12	-28	-13	-30	-6	-15
5	0	3	3	-1	3	12	-2	-1	6	-1	-11	-22	-9	-22	-4	-5	-38	6	-19	15	-28
6	0	-1	3	1	3	9	-6	2	0	-6	-13	-21	-19	-22	-12	-20	-36	0	-29	9	-33
7	0	-1	2	0	0	7	-4	-4	-3	-5	-11	-22	-14	-29	-9	-19	-29	-14	-30	-11	-26
8	0	23	12	1	9	25	20	6	2	16	6	-4	15	4	22	-9	-18	3	-24	25	0
9	0	21	15	5	15	21	20	7	5	15	4	-5	11	5	13	-13	-15	10	-18	11	-4
10	0	17	9	1	3	22	15	4	0	21	6	0	10	10	26	-1	-17	10	-17	25	2
11	0	9	9	-3	-3	9	12	7	-5	12	1	2	-5	1	19	-12	-16	5	-30	-2	-20
12	0	7	9	1	-1	10	10	7	-3	8	-2	3	-1	-4	14	-8	-11	-10	-23	19	-15
13	0	9	9	0	-3	13	11	3	-2	15	0	-1	3	1	14	-14	-9	-8	-39	-3	-9
14	0	10	7	2	0	12	8	4	1	9	0	0	-1	2	14	-24	-11	-2	-47	-13	-8
15	0	5	6	0	-4	9	10	1	-2	12	-3	-4	0	9	10	-26	-9	-1	-50	-15	-7
16	0	9	10	1	-4	12	15	5	-1	17	-1	-4	-1	11	10	-26	-12	-1	-48	-16	-15
17	0	11	11	-1	-4	12	15	5	-4	17	-3	-6	-3	12	9	-28	-15	-3	-51	-19	-17
18	0	9	10	-4	-4	9	11	6	-4	14	-6	-7	-4	13	3	-32	-12	-1	-55	-22	-20
19	0	7	12	-3	-3	9	9	7	-6	10	-4	-7	-3	-1	1	-27	-12	-19	-48	-15	-25
20	0	5	10	-5	-4	5	4	4	-10	6	-9	-13	-5	-3	-3	-36	-13	-17	-54	-29	-29
21	0	1	8	-3	-5	1	-2	7	-9	-2	-9	-10	0	-14	-3	-32	-17	-22	-46	-31	-41
22	0	-1	5	-1	-5	-5	-13	1	-3	-24	-19	-9	0	-23	-12	-22	-10	-17	-38	-1	-30
23	0	1	3	-2	-5	-4	-17	0	-5	-27	-19	-9	1	-26	-7	-26	-6	-25	-37	-11	-34

TABLE IB (Continued)

Node No.	A0	B1	B2	B3	B4	C1	C2	C3	C4	D1	D2	D3	D4	E1	E2	E3	E4	F1	F2	F3	F4
24	0	-11	2	1	-2	-4	-16	2	-2	-24	-20	-8	5	-29	-11	-29	3	-31	-49	-22	-23
25	0	-15	2	2	-2	-5	-14	1	-2	-21	-23	-10	7	-27	-12	-29	12	-32	-50	-27	-19
26	0	-15	2	1	-4	-10	-14	1	-4	-20	-22	-11	5	-27	-7	-29	12	-25	-45	-25	-27
27	0	-14	4	2	-2	-8	-14	1	-3	-19	-19	-7	8	-32	-1	-28	9	-13	-36	-7	-19
28	0	-16	3	1	-6	-13	-12	0	-5	-19	-20	-11	1	-28	-2	-29	5	-17	-33	-23	-40
29	0	-16	1	-1	-8	-15	-13	-2	-7	-20	-24	-17	-1	-25	-5	-32	2	-12	-36	-27	-45
30	0	-20	0	-2	-7	-12	-18	-3	-8	-21	-21	-12	-1	-33	-2	-27	2	-9	-27	-5	-29
31	0	-5	5	7	-3	-8	-9	6	-6	-11	-16	-10	3	-13	13	-18	7	3	-12	4	-31
32	0	-10	8	3	-11	-11	-15	4	-8	-11	-13	-11	-14	-9	6	-30	-8	22	-22	-9	-48
33	0	-14	-3	-5	-11	-15	-13	-8	-10	-16	-32	-25	0	-19	-8	-35	-4	-9	-41	-35	-41
34	0	-10	-3	-6	-11	-14	-13	-7	-14	-11	-28	-26	4	-12	-8	-38	-3	-3	-42	-38	-38
35	0	-10	-3	-3	-9	-13	-13	-5	-13	-9	-22	-23	-3	-4	-2	-39	-11	3	-35	-41	-36
36	0	-10	-3	-4	-9	-13	-15	-7	-14	-14	-26	-26	-5	-9	-12	-49	-10	-3	-41	-48	-35
37	0	-9	-3	-5	-10	-14	-13	-9	-15	-10	-30	-27	-13	-6	-10	-52	-17	4	-45	-47	-33
38	0	-3	-2	-5	-8	-10	-10	-9	-13	-7	-30	-25	-15	5	-4	-48	-17	21	-42	-42	-31
39	0	-9	-2	-5	-9	-15	-11	-9	-13	-12	-30	-27	-17	0	-8	-49	-18	8	-41	-45	-31
40	0	-6	-3	-3	-9	-12	-12	-10	-13	-10	-30	-21	-20	-8	-10	-46	-20	7	-37	-35	-34
41*	0	-6	-3	-3	-9	-12	-12	-10	-13	-10	-30	-21	-20	-8	-10	-46	-20	7	-37	-35	-34
42	0	-9	0	-2	-9	-13	-7	-5	-14	-10	-18	-24	-7	-18	1	-31	-15	7	-21	-45	-59
43	0	-8	-3	-3	-9	-12	-9	-7	-15	-5	-19	-26	-3	-11	-2	-37	-22	9	-31	-50	-49
44	0	-8	0	-1	-10	-12	-7	-3	-13	-6	-17	-21	-7	-11	-10	-35	-21	9	-33	-41	-52
45	0	-11	-13	2	-12	-16	-18	-19	-11	-18	-32	-17	-36	-28	-17	-29	-21	-6	-34	-10	-70
46	0	-10	-16	-4	-8	-19	-21	-21	-9	-19	-35	-19	-42	-47	-21	-22	-19	-27	-35	-12	-95

TABLE IB (Continued)

Node No.	A0	B1	B2	B3	B4	C1	C2	C3	C4	D1	D2	D3	D4	E1	E2	E3	E4	F1	F2	F3	F4
47	0	-8	-22	-3	-7	-19	-20	-26	-7	-19	-40	-19	-37	-43	-23	-28	-16	-22	-49	-28	-89
48	0	-3	-20	-7	-2	-11	-21	-23	-1	-12	-39	-18	-32	-35	-30	-29	-7	-13	-53	-32	-79
49	0	3	-19	0	4	-3	-28	-15	4	-5	-35	-14	-23	-25	-40	-30	-2	-8	-53	-17	-70
50	0	-3	-19	-2	5	-1	-26	-16	4	-4	-39	-15	-20	-27	-42	-32	-5	-6	-59	-16	-71
51	0	-3	-18	-2	9	1	-27	-16	9	-5	-39	-15	-19	-27	-45	-35	-3	-4	-58	-16	-74
52	0	-4	-20	-2	11	4	-31	-17	12	-5	-43	-15	-15	-23	-47	-47	7	-9	-58	-16	-70
53	0	-4	-18	-2	11	5	-29	-18	12	-5	-42	-16	-13	-24	-50	-42	5	-5	-66	-29	-74
54	0	-6	-19	-3	10	4	-31	-19	11	-10	-43	-15	-14	-28	-57	-36	5	-15	-70	-25	-74
55	0	-4	-19	-2	13	7	-31	-20	14	-6	-44	-15	-10	-23	-57	-46	16	-5	-71	-23	-73
56	0	-3	-18	-2	12	8	-28	-18	15	-2	-42	-14	-8	-17	-49	-52	9	1	-64	-39	-75
57	0	-3	-21	-5	12	9	-32	-19	14	-4	-44	-17	-8	-18	-44	-49	11	-1	-58	-25	-79
58	0	12	-15	-18	12	3	-14	-29	6	-2	-28	-51	-18	-19	-28	-67	-3	-10	-65	-95	-61
59	0	14	0	-3	-1	14	8	4	-5	-3	-3	-44	-22	-8	24	-30	-55	-29	-5	-75	-71
60	0	5	6	12	6	16	2	24	11	16	-1	0	21	28	41	-7	12	58	-7	18	20
61	0	7	-2	-3	-4	20	7	-6	-5	23	-4	-32	-4	19	26	-47	-33	57	-29	-26	-22
62	0	13	16	4	4	14	13	13	-5	26	8	-14	10	36	17	-44	-51	62	-17	-16	-44
63	0	8	-1	-6	0	19	7	1	-12	34	-2	-29	3	49	7	-48	-54	65	-31	-43	-43
64	0	9	16	-6	-9	10	10	7	-14	36	5	-34	14	43	12	-52	-55	86	-32	-69	-43
65	0	9	13	4	-1	22	18	10	-11	35	10	-19	7	33	33	-28	-28	67	-14	-22	-31
66	0	-6	3	6	-11	-8	3	5	-9	7	-2	-16	-6	-3	10	-15	-21	12	9	7	-70
67	0	5	-1	-5	-6	0	1	-10	-24	11	-20	-42	-14	16	-27	-63	-72	31	-58	-67	-77
68	0	0	9	-9	-13	-4	5	-3	-32	13	-19	-44	-13	23	-15	-58	-78	33	-50	-64	-77
69	0	-4	-6	-7	-10	-9	-11	-18	-32	3	-32	-51	-23	5	-26	-72	-85	22	-65	-80	-82

TABLE IB (Continued)

Node No.	A0	B1	B2	B3	B4	C1	C2	C3	C4	D1	D2	D3	D4	E1	E2	E3	E4	F1	F2	F3	F4
70	0	-1	-6	-3	-9	-2	-10	-16	-25	7	-29	-50	-17	11	-26	-76	-86	26	-69	-89	-73
71	0	2	-3	4	-3	3	-4	-9	-6	12	-19	-37	-6	13	-23	-75	-76	19	-62	-91	-53
72	0	1	-3	5	-4	4	-3	-6	-6	10	-16	-31	-4	15	-25	-76	-70	19	-65	-89	-46
73	0	10	5	-4	-3	11	2	0	-20	4	-19	-35	4	16	-21	-64	-75	15	-54	-87	-54
74	0	-2	5	3	-3	-3	-7	3	1	-8	-7	-11	-18	-11	-11	7	-24	-10	-23	-42	-42
75	0	-7	-4	-3	2	-3	-10	-5	-5	-5	-12	-18	-8	-7	-30	-7	-31	-40	-59	-54	-57
76	0	-8	-3	1	-5	-21	-11	-7	-2	-23	-31	-14	-3	-15	-51	-46	-33	-37	-77	-77	-65
77*	0	-8	-3	1	-5	-21	-11	-7	-2	-23	-31	-14	-3	-15	-51	-46	-33	-37	-77	-77	-65
78	0	1	-5	5	-1	-12	-10	-9	-5	-11	-42	-13	-12	-8	-45	-58	-50	-22	-85	-91	-57
79	0	-2	-7	3	-1	-2	-10	-12	-7	-6	-40	-20	-3	-15	-38	-55	-57	-21	-79	-92	-57
80	0	2	-3	5	1	2	-7	-10	-7	2	-40	-20	-2	-8	-29	-57	-54	-4	-75	-93	-50
81	0	-2	-8	2	-3	-4	-14	-14	-4	-9	-48	-18	-2	-12	-46	-55	-58	-24	-80	-86	-60
82	0	-4	-12	4	-3	-7	-16	-17	-2	-11	-49	-16	-6	-14	-47	-55	-48	-27	-86	-78	-60
83	0	-3	-17	7	1	-5	-22	-22	0	-12	-54	-11	-6	-12	-45	-58	-44	-26	-82	-76	-58
84	0	-3	-25	7	3	-3	-28	-29	7	-19	-56	-9	-4	-9	-53	-59	-39	-32	-86	-77	-54
85	0	-3	-21	7	6	3	-24	-28	8	-15	-59	-6	-1	-2	-51	-57	-32	-27	-77	-67	-47
86	0	-5	-25	6	9	1	-27	-30	14	-21	-63	-5	5	-6	-47	-51	-27	-23	-67	-58	-43
87	0	-2	-23	6	9	4	-31	-27	13	-15	-55	-6	4	-2	-43	-54	-28	-25	-66	-60	-46
88	0	-8	-17	4	1	-6	-23	-35	7	-26	-64	-7	-2	-11	-49	-59	-34	-16	-75	-61	-46
89	0	-7	-9	5	-1	-14	-15	-28	0	-27	-64	-12	-9	-26	-55	-57	-39	-35	-94	-74	-55
90	0	-7	-22	6	6	-4	-25	-39	14	-23	-58	-7	5	-4	-46	-60	-26	-10	-70	-58	-34
91	0	-7	-22	6	2	-4	-22	-38	11	-20	-60	-3	-2	-2	-42	-57	-28	-5	-63	-58	-37
92	0	-6	-23	2	1	-3	-14	-38	7	-18	-59	-8	-4	2	-33	-64	-23	-2	-72	-55	-37

TABLE IB (Continued)

Node No.	A0	B1	B2	B3	B4	C1	C2	C3	C4	D1	D2	D3	D4	E1	E2	E3	E4	F1	F2	F3	F4
93	0	3	-18	2	10	16	-18	-25	26	4	-38	- 5	11	4	-17	-21	- 1	- 1	-21	-25	-19
94	0	3	-13	2	15	14	- 5	-23	23	6	-23	- 2	13	9	- 3	-14	-22	28	-27	-51	-31
95	0	6	-19	3	19	14	-14	-27	21	4	-35	5	6	10	- 9	-41	-17	28	-39	-48	-42
96	0	- 5	-16	3	11	8	-25	-19	9	-36	-60	-12	- 3	-26	-30	-49	-37	-23	-63	-55	-65
97	0	-12	- 5	0	- 5	-11	-13	-11	- 2	-17	-31	- 7	- 8	-21	-47	-16	-27	-42	-68	-26	-50
98	0	3	- 7	- 2	6	0	-13	-11	1	- 7	-37	- 8	0	- 5	-23	-21	-22	-12	-52	-36	-64
99	0	-11	-21	- 3	13	- 5	-29	-28	-10	-15	-53	-22	1	- 3	-16	-43	-35	-13	-50	-35	-62
100	0	- 6	-16	5	4	- 9	-17	-19	14	- 9	-41	-13	- 5	- 1	- 8	-43	-38	- 8	-42	-63	-54
101	0	- 2	-12	1	6	3	-12	-20	13	-10	-42	- 7	2	- 5	2	-43	-38	23	-44	-71	-36
102	0	0	- 7	2	4	0	- 9	-25	10	-18	-44	- 7	- 2	0	- 6	-43	-43	29	-46	-88	-30
103	0	- 6	-17	4	4	0	-19	-30	17	- 9	-43	-13	- 1	2	- 9	-46	-39	29	-51	-90	-34
104	0	0	-14	0	12	4	-15	-25	25	- 8	-37	-19	8	3	- 8	-42	-24	22	-56	-68	-26
105	0	- 9	-20	- 4	15	7	- 9	-29	31	- 6	-45	-31	19	- 8	-24	-62	-21	13	-81	-72	- 2
106	0	19	-12	- 2	27	31	- 6	-26	33	26	-30	-19	54	22	-29	-46	18	35	-88	-45	- 2
107	0	8	-11	- 1	29	34	- 8	-18	33	28	-30	-15	57	29	-38	-43	25	27	-83	-27	- 8
108	0	- 8	-12	0	6	30	-15	-25	21	24	-21	- 4	57	16	-40	-30	43	25	-45	-30	- 9
109	0	- 5	-11	5	14	32	-11	-30	33	22	-26	7	51	29	-36	-31	18	- 3	-35	-34	-20
110	0	3	-12	- 1	18	28	- 8	-22	32	28	-32	2	52	32	-10	-45	23	24	-44	-65	-19
111	0	- 7	-15	3	16	19	-18	-17	28	23	-47	- 8	34	31	-33	-62	4	18	-71	-72	-30
112	0	- 4	-13	- 6	10	-13	-17	-22	22	9	-35	-16	4	13	-27	-51	-14	0	-57	-68	-36
113	0	2	-10	- 6	14	16	- 9	-23	22	13	-20	-18	4	17	-19	-36	- 6	17	-47	-55	-24
114	0	3	-13	- 8	15	19	-13	-28	20	13	-16	-26	- 5	25	-19	-43	-21	26	-51	-85	-13
115	0	- 7	6	- 5	- 4	- 7	3	- 4	- 5	- 4	-17	-14	- 9	- 8	- 3	-20	-33	- 8	-31	- 8	-58

TABLE IB (Continued)

Node No.	A0	B1	B2	B3	B4	C1	C2	C3	C4	D1	D2	D3	D4	E1	E2	E3	E4	F1	F2	F3	F4
116	0	-16	-10	7	0	-23	-20	-25	13	-28	-39	- 9	- 3	-16	- 5	-40	-39	13	-42	-53	-28
117	0	- 3	-14	- 3	13	2	- 8	-29	23	-11	-28	-19	16	- 9	- 7	-41	-31	30	-48	-60	-21
118	0	1	2	4	19	21	6	13	27	16	6	34	69	82	-10	45	46	81	14	31	77
119	0	5	- 7	- 7	11	27	- 3	-15	14	23	-37	- 6	67	93	-18	-12	11	99	-35	-41	72
120	0	19	- 5	- 6	22	38	9	-14	19	41	-30	- 7	76	89	-13	-39	20	90	-52	-52	58
121	0	14	- 7	- 9	20	33	5	-21	15	28	-34	-16	70	61	-15	-44	22	52	-46	-57	39
122	0	2	- 5	- 9	16	12	1	-17	18	10	-33	-12	51	32	-29	-42	29	20	-52	-56	22
123	0	11	- 8	-11	19	15	9	-24	22	15	-25	- 6	67	40	-24	-43	27	35	-55	-62	36
124	0	0	-10	- 6	15	12	8	-21	23	21	-24	- 9	61	44	-21	-42	31	31	-65	-66	26
125	0	14	- 7	- 3	26	31	10	-14	28	37	-24	- 5	83	76	2	-40	31	65	-48	-59	37
126	0	17	- 5	- 4	25	38	8	-13	27	38	-23	- 3	96	89	1	-31	27	100	-40	-43	42
127	0	7	-10	-14	10	26	0	-13	12	-72	69	-10	66	89	-35	0	6	92	-29	-28	67
128	0	11	- 2	- 6	17	32	6	-12	16	30	-25	- 3	83	96	-25	2	28	94	-19	-18	86
129	0	10	- 1	- 1	20	34	6	-11	23	31	-24	10	80	97	-20	14	46	85	-10	- 5	90
130	0	- 7	- 7	2	7	3	- 2	-11	4	0	-21	2	24	44	- 2	-15	15	46	2	-22	48
131	0	-16	-11	1	6	- 6	-17	- 6	9	-14	-26	2	38	46	-38	-31	10	15	-49	-21	36
132	0	2	- 2	7	4	8	- 1	- 1	10	6	-26	10	39	44	- 4	-28	24	54	- 6	-13	45
133	0	2	- 1	5	4	6	- 3	- 1	9	- 5	-20	11	40	39	-20	-31	29	49	10	- 7	45
134	0	4	- 2	8	3	1	- 8	- 3	13	- 2	-21	13	44	47	-17	-28	40	69	1	- 4	55
135	0	5	- 2	6	3	5	- 4	- 6	9	6	-20	5	46	54	- 6	-34	50	84	7	-11	61
136	0	4	- 1	12	6	11	- 5	- 2	10	21	-21	9	44	59	-17	-26	30	80	12	-34	56
137	0	6	3	5	7	15	2	0	3	1	-26	2	35	43	-15	-39	21	74	- 2	-56	34
138	0	6	3	3	3	4	1	4	13	0	-10	21	43	33	-15	-17	24	33	8	-68	35
139	0	1	2	- 1	6	6	1	6	4	0	-13	7	39	43	- 6	-29	24	72	7	-50	32

TABLE IB (Continued)

Node No.	A0	B1	B2	B3	B4	C1	C2	C3	C4	D1	D2	D3	D4	E1	E2	E3	E4	F1	F2	F3	F4
140	0	-2	5	3	8	8	3	5	14	3	-5	17	47	45	-7	-10	26	69	5	-26	35
141	0	0	0	1	3	13	4	-1	12	-5	-3	15	56	51	-13	7	35	73	14	-17	47
142	0	-11	-2	-3	3	6	-3	-2	12	-1	-9	16	51	53	-27	12	34	56	15	-8	46
143	0	-4	0	3	9	14	0	-4	18	6	-7	18	61	60	3	3	30	77	21	-6	43
144	0	1	-2	2	15	22	-1	-3	20	22	3	25	65	75	-21	24	46	77	16	3	77
145	0	5	-2	2	19	28	7	-7	20	24	-34	22	75	79	-29	21	54	72	-4	9	91
146	0	1	1	8	17	24	-2	0	25	13	-7	27	67	87	-12	15	46	87	32	5	64
147	0	1	-2	8	19	25	-3	-1	27	15	-6	26	74	90	-15	3	49	87	24	-3	64
148	0	-9	-4	1	11	11	-13	-7	18	-5	-20	14	63	69	-22	-9	35	73	2	-4	56
149	0	3	-7	3	21	32	-8	-13	27	16	-27	13	70	80	-25	-5	49	70	-4	-11	37
150	0	2	-8	7	21	28	-7	-10	28	15	-18	19	86	95	-20	-5	49	86	3	-13	64
151	0	-3	-3	4	13	17	-14	-7	23	5	-14	14	73	86	-25	-14	37	79	0	-18	57
152	0	-4	-4	0	11	14	-12	-7	17	-5	-21	12	63	74	-31	-15	38	65	-15	-4	51
153	0	-5	-6	1	12	14	-16	-8	20	0	-19	12	66	78	-29	-17	40	68	-15	-10	48
154	0	-5	-9	0	13	16	-19	-13	22	1	-19	7	67	77	-37	-20	42	64	-14	-7	40
155	0	-4	-11	3	19	26	-16	-13	23	8	-30	9	68	75	-34	-12	46	68	-14	-10	29
156	0	-3	-5	4	17	29	-18	-14	26	13	-35	12	60	59	-40	-8	43	49	-20	-9	14
157	0	-1	-7	-1	13	25	-19	-14	22	12	-34	8	52	50	-45	-10	38	42	-23	-5	5
158	0	1	-10	-3	14	26	-18	-13	21	15	-33	6	51	43	-45	-6	35	40	-21	-2	0
159	0	4	-11	-2	18	30	-11	-14	24	22	-24	5	52	36	-39	0	34	47	-14	2	2
160	0	1	-10	-1	17	28	-11	-13	23	20	-16	8	50	34	-38	1	33	41	-14	2	0
161	0	0	-9	-3	16	27	-13	-14	22	16	-18	10	49	37	-41	-2	36	41	-14	0	0
162	0	0	-12	-2	17	27	-11	-13	24	16	-17	14	45	24	-36	3	31	36	-8	4	-3

TABLE IB (Continued)

Node No.	A0	B1	B2	B3	B4	C1	C2	C3	C4	D1	D2	D3	D4	E1	E2	E3	E4	F1	F2	F3	F4
163	0	3	-11	- 2	18	28	-10	-13	27	18	-20	9	55	30	-37	- 6	30	48	-13	0	4
164	0	3	-12	- 2	17	27	-10	-14	26	19	-19	5	49	25	-36	- 5	26	49	-13	2	3
165	0	4	-12	- 1	21	30	- 8	-14	26	23	-15	13	47	33	-34	2	30	48	- 9	6	1
166	0	4	-14	- 3	19	30	-10	-16	26	23	-20	0	47	32	-43	- 6	29	49	-23	0	8
167	0	2	-12	- 1	16	23	-11	- 9	26	15	-16	5	52	23	-32	- 5	28	54	- 8	10	- 8
168	0	2	-14	- 5	17	23	-15	- 5	26	10	-24	10	44	19	-45	- 5	28	40	-13	13	-10
169	0	- 4	-13	- 2	16	20	-19	- 8	22	8	-33	1	47	37	-52	-20	23	13	-49	-51	-20
170	0	1	-15	- 3	24	23	-14	-11	24	11	-22	- 8	39	33	-48	-25	23	0	-37	-62	-25
171	0	4	-13	- 2	23	27	- 9	- 7	21	17	-22	- 6	48	47	-38	-28	19	24	-35	-63	-18
172	0	4	-15	- 1	24	25	- 9	- 6	15	19	-15	-13	40	52	-38	-31	14	28	-36	-61	- 8
173	0	19	- 5	2	30	35	- 1	- 5	17	26	-11	-14	44	61	-35	-18	24	50	-18	-52	13
174	0	7	- 6	0	27	32	1	- 2	21	23	-17	- 3	53	58	-26	-20	30	62	-18	-34	23
175	0	4	- 8	3	22	27	- 7	- 2	17	19	-10	- 9	50	61	-28	-11	29	56	-14	-12	2
176	0	6	-10	1	15	18	- 6	- 1	7	9	- 9	- 5	31	45	-23	- 8	11	64	-38	-24	- 9
177	0	- 6	-10	0	13	15	-18	- 3	15	- 3	-25	- 4	48	51	-46	-17	10	55	-66	-21	- 6
178	0	- 6	- 7	6	7	5	-18	2	18	-17	-23	9	44	65	-47	-37	23	60	-73	-38	0
179	0	- 7	- 2	19	16	13	1	10	30	11	- 4	35	70	60	- 6	- 2	60	64	-18	5	25
180	0	4	0	8	12	13	- 4	10	19	4	-14	19	58	59	-11	-14	42	69	- 6	-19	47
181	0	- 3	-16	- 3	34	37	-10	-11	27	12	-26	-15	59	51	-30	-46	51	81	-47	-25	15
182	0	10	- 6	- 5	17	23	4	-16	-28	20	-15	-20	49	91	41	-35	- 2	47	37	0	60
183	0	-28	- 7	4	3	-17	-25	11	6	-58	-13	34	31	-14	-82	53	87	-107	13	171	-45

* Nodes duplicated for interpolation purposes.